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### BAT CAVE REVISITED

BY

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IN 1948 an expedition sponsored by the Peabody Museum of Harvard University and led by Mr. Herbert Dick, then a graduate student, uncovered many cobs and other parts of maize from the accumulated refuse in a once-inhabited rock shelter in New Mexico known as Bat Cave. These prehistoric remains were significant in several respects: (1) they were the first remains discovered which showed clearly the nature of primitive maize; (2) they provided tangible evidence of a well defined evolutionary sequence; (3) they represented the first archaeological evidence showing: (A) that primitive maize was both a popcorn and a form of pod corn, (B) that maize did not originate from teosinte, (C) that much of the variation in modern maize is the product of introgression from teosinte (Mangelsdorf and Smith, 1949).

Since the 1948 expedition had excavated only one section of the cave, Mr. Dick in 1950 made a second expedition which excavated additional sections in the hope of finding still older vegetal remains. A preliminary

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examination of the maize specimens of this second expedition showed that the earliest cobs were even more primitive in some respects than those found in the 1948 excavation and the specimens tended to confirm in general the principal conclusions drawn from the detailed study which had been made of the 1948 collection. It was our intention at that time to make a similar detailed study of the 1950 collection and to publish the results at an early date. In the meantime, however, the senior author participated in a project involving the classification and description of the living races of maize of Mexico (Wellhausen *et al.*, 1952) and this made it possible to identify precursors of several living races of maize found in archaeological excavations in northeastern Mexico by MacNeish (Mangelsdorf *et al.*, 1956) and in northwestern Mexico by Lister (Mangelsdorf and Lister, 1956). Studies of still other collections of archaeological maize had shown strikingly the importance of teosinte introgression in the evolution of maize (Galinat *et al.*, 1956). In view of these developments, it was decided to postpone the final studies of the 1950 collection of Bat Cave specimens until still other collections which had come to the Botanical Museum from various sources could be analyzed. These several studies of specimens from sites in Mexico and the United States have been completed (Galinat and Ruppe, 1961; Galinat and Gunnerson, 1963; Mangelsdorf *et al.*, 1964; Mangelsdorf *et al.*, in press). We can now re-examine the two Bat Cave collections with the benefit of a familiarity with the living races of maize, a considerably greater experience in analyzing archaeological material, and in the light of significant evidence revealed by other collections of which one of the most important is from sites in the Valley of Tehuacán in Mexico in which remains of prehistoric wild corn were found.

## THE 1950 EXCAVATION

Since the Bat Cave site and its environs were described in detail in the 1949 report as well as in a more recent publication (Dick, 1965) there is no need to repeat the description here.

The 1950 expedition comprised three members all from the University of Colorado; Herbert W. Dick, who directed the excavation, Francis Olson and Allen Olson. The excavation was made from August 1 to September 6.

The main purpose of the second expedition was to obtain additional prehistoric vegetal material, especially of maize, and charcoal from all levels for radiocarbon dating. Stone and other artifacts were collected as by-products. Except for finding a new type of knotted-fiber container these proved to be similar in virtually all respects to those turned up in the 1948 excavation.

Because there was no obvious stratigraphy in the cave corresponding to cultural phases, the material was removed in arbitrary strata of 12 inches each: 0-12'', 12-24'', etc. Since three different sections of the cave were excavated and since the sterile sand representing Antevs' dry level on which the cave deposits rest, occurs at different levels in different parts of the cave, it might be supposed that arbitrary levels in one section would not correspond to those in another. In Section IB for example, the sterile sand occurs at 36'' while in IC it is found at 60''. However, the cobs in the 24-36'' level of IB are similar to those in the 24-36'' level of other sections. Consequently we have averaged the data on cobs and kernels according to the arbitrary levels in which the specimens were found. Although this procedure lacks refinement it still demonstrates an evolutionary sequence of the maize remains from the lower to the upper levels of the deposit.

### *Dating of the Remains*

One of the most important questions to be answered is the date of the remains. The radiocarbon determinations (Libby, 1951; Arnold and Libby, 1950) of samples of charcoal and other materials from the several levels are set forth in Table I. The data from the two excavations are fairly consistent for the three uppermost levels but differ widely for the two lower levels. There is reason to believe that the date of 5605 for the charcoal in the 48-60'' level is not valid for the associated earliest maize.

TABLE I. Radiocarbon dates of charcoal, wood fragments, and cobs from the two Bat Cave excavations.

1948 Excavations			1950 Excavations		
Material	Level	Date	Material	Level	Date
cobs	0-12''	1752 ± 250			
wood	12-24''	1907 ± 250	Charcoal	11-15''	1610 ± 200
wood	24-36''	2239 ± 250	“	24-36''	2816 ± 200
cobs, wood	36-48''	2249 ± 250	“	36-48''	2048 ± 170
wood	48-60''	2862 ± 250	“	48-60''	5605 ± 290
[extrapolation]	60-66''	3000-3500	“	60-66''	5931 ± 310

On the basis of the characteristics of the cobs, especially those which represent evidence of teosinte contamination, we have concluded that the maize from the 48-60'' level of Bat Cave is later than the maize of the Abejas phase in the Tehuacán caves and earlier than that of the Ajalpan phase. This would date it at between 2300 and 1500 B.C. A similar correlation with the remains of maize in Romero's Cave, Tamaulipas, Mexico, excavated by Dr. Richard S. MacNeish (in press) makes it contemporary with the Guerrero phase dated by radiocarbon at 1800-1400 B.C. These correlations suggest that the earliest Bat Cave maize is probably not earlier than

ca 2300 B.C. and may be several centuries later.

The 1950 Bat Cave collection comprises 816 specimens and includes cobs, eroded fragments of cobs, kernels, husk systems and husk fragments, peduncles, pieces of stalk, and one tassel fragment. We shall consider these below in relation to the levels in which they were found in the Cave.

### THE COBS

On the whole the cobs from this collection, numbering 444 specimens in addition to one fragment bearing kernels, were quite similar to those of the earlier excavation but with one important difference. Some of the cobs from the lowest levels were smaller and more primitive than any of those previously turned up at this site. Three of these are illustrated in Plate III, A.

#### *Early Maize a Popcorn*

The senior author and his associate, Dr. Walton C. Galinat, made an intensive study of one of these specimens which contained the partial remains of a single kernel. We spent several days in dissecting this cob and measuring all of its parts. On the basis of these measurements, Galinat prepared the diagrammatical longitudinal section illustrated in Fig. 1. We concluded that the tiny kernels which this cob must once have borne could only have been those of popcorn, a type in which the kernels are small and hard and are capable of exploding when exposed to heat. This conclusion has been amply confirmed by finding among the prehistoric grains several actual specimens of popped corn described later. The Bat Cave specimens thus provide convincing archaeological evidence in support of one part of the conclusion first reached by Sturtevant (1894) and later by Mangelsdorf and Reeves (1939) that primitive corn was both a popcorn and a pod corn.

## *Early Maize a Pod Corn?*

Whether the earliest Bat Cave corn was also a pod corn depends upon how pod corn is defined. Geneticists know that the principal characteristics of pod corn are controlled by a single locus, *Tu*, on chromosome 4. Mangelsdorf and Reeves (1939) considered the *Tu* gene to be an ancient wild one still surviving in modern varieties but they also pointed out that the pod corn of today is not the pod corn of wild corn:

The pod corn found occasionally as a mixture in modern cultivated varieties is certainly not the wild pod corn which the wandering Indians discovered millenia ago. Modern pod corn is the result of superimposing a single 'wild' gene with perhaps a few closely linked modifiers upon a genetic complex which has been tremendously altered by centuries of domestication.

Intensive research on pod corn and its genetic locus by the senior author and his associates over a period of almost 30 years has shown that *Tu* locus is a compound

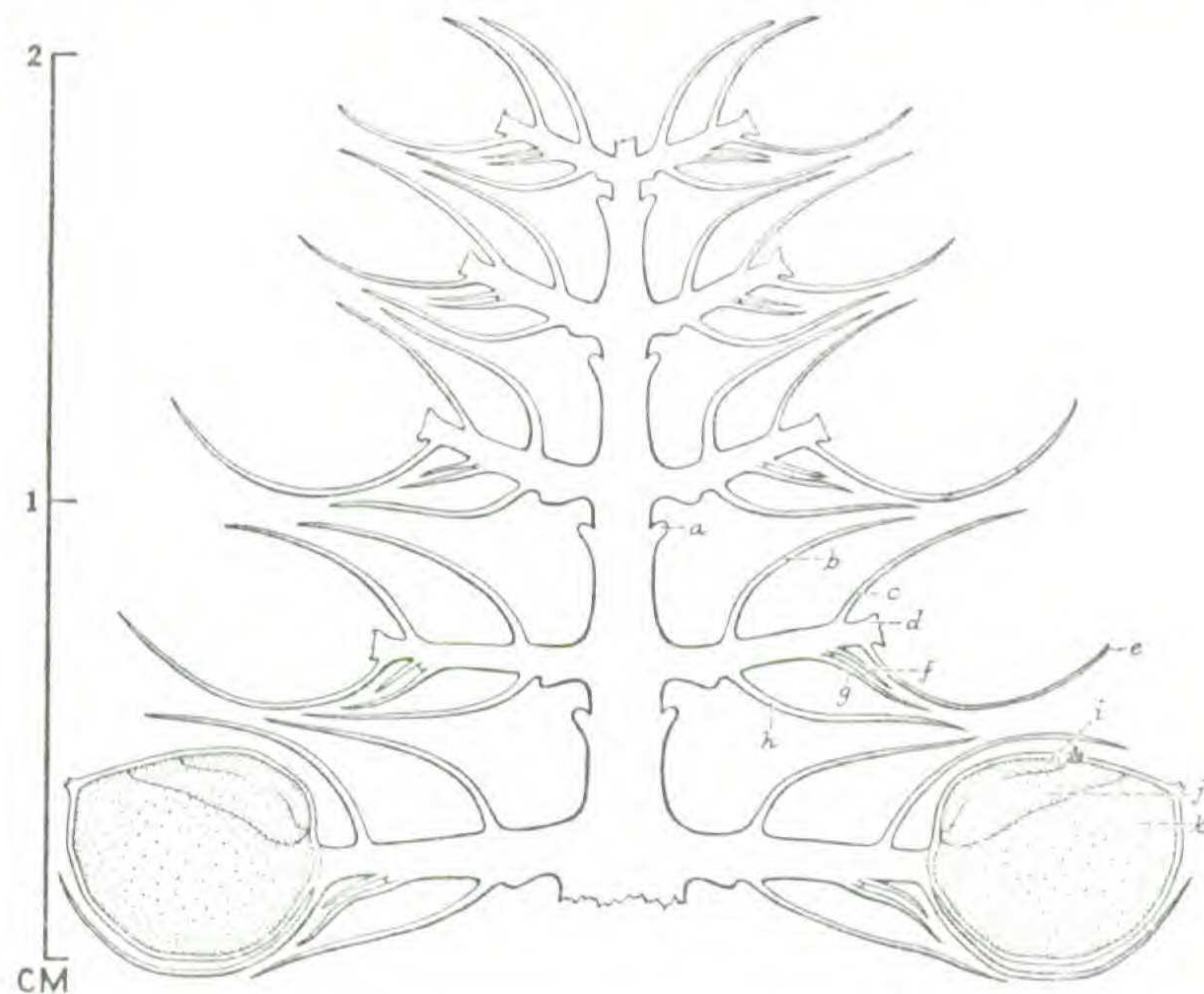


FIG. 1. Diagrammatic longitudinal section of one of the Bat Cave cobs based on measurements of dissected parts. The tiny kernels show that this was a popcorn; the long pedicels on which the kernels are borne and the bracts which almost enclose them indicate that it was also a pod corn.

*Drawn by W. C. GALINAT*

one having at least two components (Mangelsdorf and Galinat, 1964) and possibly three, one of which is identical in its expression with a previously recognized mutation at this locus designated as "half-tunicate" because its effects are about half of those of tunicate (cf. Mangelsdorf and Reeves, 1959). We also discovered in the popcorn variety, Baby Golden, a major modifying gene which we have called tunicate inhibitor and given the symbol, *Ti*. This gene has its locus on chromosome 6 and is linked with the gene for endosperm color on that chromosome. Combinations of the several components of the *Tu-tu* locus with and without the major modifying factor *Ti* produce a spectrum of phenotypes at one end of which all of the kernels are completely enclosed in glumes and at the other all of the kernels are completely exposed in their upper surfaces but are surrounded in their lower surfaces by glumes which are longer than those of modern varieties of corn.

The earliest cobs from the Bat Cave 1950 collection are of this latter phenotype as the diagram in Fig. 1 shows. They have relatively long floral bracts, the lemmas and paleas surrounding the kernels but not completely enclosing them. In the 1950 collection we have also found one fragment of a cob containing kernels which shows exactly this condition. This is illustrated in an enlarged photograph in Plate II, C, D, and in Fig. 2.

The earliest cobs also have other characteristics of pod corn including the slender central stem, the rachis, and relatively long secondary stems, the pedicels or rachillae, upon which the kernels are borne.

There has been some skepticism with respect to our conclusion that cobs of this type represent pod corn (Randolph, 1956; Weatherwax, 1956; Goodman, 1965). Since prehistoric kernels from such cobs, even when present, have long since lost their viability there is no

way of determining their genotype, However, since we can duplicate the principal characteristics of such specimens by combining the components of the *Tu* locus on chromosome 4 with the major modifying factor *Ti* on chromosome 6 and with other modifying genes from various popcorn varieties and since neither we nor our critics have yet found any other way to duplicate these characteristics, we shall continue to regard these early

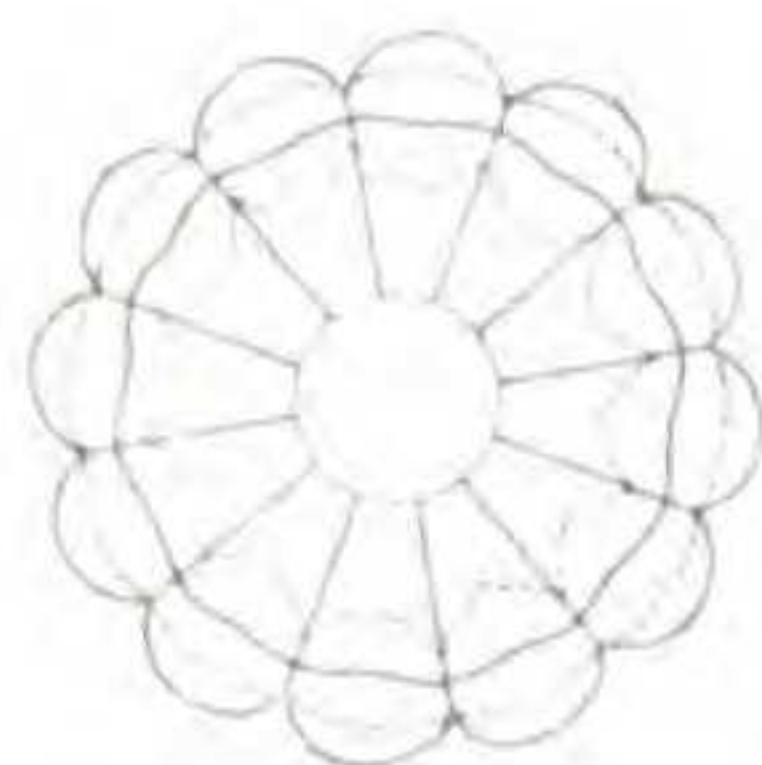


FIG. 2. Diagrammatic cross section of the early Bat Cave cob illustrated in Plate II, C and D. The slender rachis (inner circle), the long rachillae (distance between rachis and base of kernels), the long glumes (solid line), and the paleas (broken line) which almost enclose the kernels, all indicate that this is a form of pod corn.

cobs as representing a form of pod corn and we shall adhere to the conclusions of Sturtevant and of Mangelsdorf and Reeves that primitive corn was both a popcorn and a pod corn.

#### *Changes in the Rachis Diameter*

We shall, however, modify the conclusion reached in the description of the cobs from the 1948 collection in which we attributed changes in the cob/rachis ratio largely to replacement of higher alleles of the *Tu-tu* locus by lower alleles including one designated as *tu<sup>w</sup>*. We have not in our experimental cultures been able definitely to establish the existence of such an allele or if it exists to distinguish its effects from those of various modifying factors whose role, in causing variation in the diameter of the rachis and the length of the glumes, was postulated in the 1949 paper. Changes in the cob/rachis ratio in this material now appear to be more a matter of increase in the diameter of the rachis than in the reduction in the length of the glumes. The data in Table II, based on 430 cobs in which the rachis diameter could be measured, show that there has been an increase in the



rachis diameter from 7.0 mm. to 8.9 mm. in the period represented by the remains of maize in this cave.

*Increase in Variation*

More conspicuous than the increase in the size of the rachis is the increase in variation of the cobs. Several of the earliest cobs from the 1950 collection resemble the prehistoric wild corn from the Tehuacán site but not all

TABLE II. Rachis diameters (mm.) and kernel-row-numbers of the cobs from successive levels of Bat Cave.

Level Inches	Rachis Diam. Av.	Kernel-row-numbers							
		No. Cobs	8	10	12	14	16	18	Av.
0-12	8.9	70	8	20	28	12	2		11.4
12-24	7.8	99	10	25	35	22	4	3	11.8
24-36	7.9	120	12	30	55	16	5	2	10.2
36-48	7.2	142	28	42	54	13	5		10.9
48-60	7.0	13	1	9	1	2			10.6
No. Cobs	430	444	59	126	173	65	16	5	

of them are of this type. The majority of them are small but there is considerable variation in their other characteristics, especially in the size and shape of cupules. There is some evidence that introgression with teosinte had already occurred in some of the cobs from the lowest level. Based on the characteristics of the cobs we conclude that the corn from the 48-60'' level in Bat Cave, as already mentioned, is later than the corn of the Abejas phase in the Tehuacán sites and earlier than that of the Ajalpan phase.

The evidence of teosinte contamination is even more clear-cut in the specimens from the 36-48'' level than in the 48-60'' level. Photographs of several specimens with indurated tissues and solitary pistillate spikelets are illustrated in Plate I, C and E.

The cobs in this and subsequent levels are so hetero-

geneous in their characteristics that it is impossible to classify all of them with respect to race. However, some of the cobs clearly resemble those of the race Chapalote. A series of these from the lower to the higher levels is shown in Plate III, B.

Another type of cob thicker and more nearly cylindrical in shape than those resembling Chapalote is illustrated in Plate IV. These may be related to the Mexican race, Blando de Sonora, described by Wellhausen *et al.*, 1952. Some of the kernels with colorless pericarp and floury endosperm illustrated in Plate III, C may also be related to this race.

#### *Changes in Kernel-row Number*

An increase in the diameter of the rachis provides a larger surface on which kernels can be borne and this results in either a higher kernel-row number or in larger kernels or in both. Table II shows that there has been a change in the kernel-row number from the lower levels to the higher. The modal number in the lowest level is 10 and in all higher levels, 12. The average row number of the cobs from successive levels, the lowest to the upper, is 10.6, 10.9, 10.2, 11.8, and 11.4. The increase in kernel-row number has, however, been relatively smaller than the increase in kernel size discussed below.

### THE KERNELS

#### *Increase in Size*

There are 299 well preserved kernels in this collection, a much larger number than found in the 1948 material. The data in Table III show that there is a substantial increase in kernel length and width from the lower levels to the higher accompanied, however, by a decrease in thickness. The kernels from the lowest level are almost isodiametrical in their dimensions; kernels from upper levels tend to be longer, wider, and flatter.

TABLE III. Dimensions of kernels of different pericarp and aleurone colors from successive levels of Bat Cave.

Cave Level Inches	Number of Kernels and their Length, Width and Thickness in mm.																											
	Brown				Red				Variegated				Colorless				Aleurone Color				Averages							
	No.	L	W	T	No.	L	W	T	No.	L	W	T	No.	L	W	T	No.	L	W	T	No.	L	W	T				
0-12	7	7.5	7.3	5.5	1	7.4	11.3	6.9					10	8.2	8.6	5.4									18	7.9	8.2	5.5
12-24	44	6.9	6.8	5.4	10	7.6	7.1	5.3	4	8.0	7.8	5.3	74	7.8	8.1	5.6	2	8.4	8.5	6.0	134	7.5	7.6	5.5				
24-36	16	6.7	6.7	5.5									3	8.0	7.8	5.6					19	6.9	6.9	5.5				
36-48	29*	6.9	6.7	5.7	26	7.3	6.8	5.3	9	7.2	7.3	5.5	37	7.1	6.7	5.5					101	7.1	6.8	5.6				
48-60	10	6.8	6.7	5.8	1	7.7	6.5	5.3													11	6.9	6.7	5.8				

\* Ten additional brown kernels employed in a popping experiment are not included in these measurements.

### *Changes in Pericarp Color*

The majority of the kernels are so well preserved that it is possible to classify them with respect to pericarp color. Of the 293 kernels so classified: 116 are brown, 38 red, 13 variegated, 2 with colored aleurone, and 124 with colorless pericarp and aleurone.

The kernels with brown pericarp are more frequent in the lower levels than in the higher and they are smaller on the average than the kernels with red or colorless pericarp. The fact that the kernels from the lower levels of Bat Cave are predominantly brown suggests that this is the primitive or "wild" color. Also most of the early prehistoric corn in South America has brown pericarp color as do the kernels of corn's relative, teosinte and *Tripsacum*.

Pericarp color in maize is the product of the interaction of genes at two, in some cases three, different loci. Brown pericarp results when the *P* factor on chromosome 1 interacts with one of the several alleles at the *A* locus on chromosome 3:  $A^{b_1}$ ,  $a^{p_1}$ , and  $a_1$ . Since the kernels from the lower levels are predominantly brown and since the  $a_1$  allele is not common in maize, it seems probable that the genotype of the early kernels is  $A^{b_1}A^{b_1}PP$ . The red kernels probably represent mutations to  $A_1$ , perhaps resulting from the introgression of teosinte which is known to have mutagenic effects (Mangelsdorf, 1958).

*Variegated Pericarp.* Thirteen of the 299 kernels had variegated pericarp. This variegation is the product of a mutation system which has been intensively studied by Brink and his associates and which involves the interaction of genes at the *P* locus on chromosome 1 with a genetic factor designated as "modulator" which may occupy various positions on chromosome 1 or on other chromosomes. The fact that nine of the 13 variegated

kernels occur in the 36-48'' level indicates that a mutation system similar to that studied by Brink was already in existence at an early date and the fact that the variegated kernels are larger than either the brown or red kernels suggests that the modulator system may have caused or been accompanied by other mutations involving increases in size.

*Colorless Pericarp.* The kernels with colorless pericarp are generally larger than those with colored pericarp and are predominantly floury. They may belong to the race, Blando de Sonora, described by Wellhausen *et al.*, 1952. We have already suggested that certain cobs may belong to this race.

### *Popped Kernels*

In addition to the 293 kernels classified with respect to color there were six popped or partially popped kernels in which the color could not be determined with certainty but which appeared to have brown pericarp. One of these is illustrated in Plate III, D. We were able by a simple experiment to demonstrate that the early Bat Cave kernels were capable of popping. To increase their moisture content, we placed ten of the smaller brown kernels from the 36-48'' level in a petri dish with a piece of moist paper towel for 48 hours. When dropped into hot oil all of these popped in varying degrees. One of these, a popped-prehistoric kernel, is illustrated in Plate III, D where it is compared with a prehistoric-popped kernel from the same level.

### PEDUNCLES

Twenty-one specimens of peduncles or "shanks" were found in this collection. Those from the lower levels were usually more slender than those from the higher levels as is shown by the specimens illustrated in Plate

V. Part of the increase in size may be the result of clusters of small ears being replaced by single large ears as discussed below.

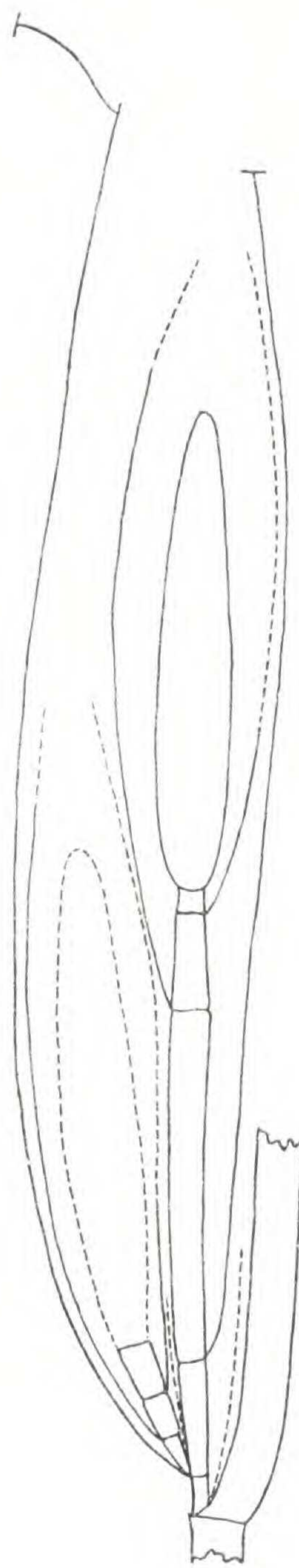
### HUSKS

The most important modification of a conclusion based on the 1948 collections, which resulted from a study of the 1950 specimens, is concerned with the nature of the husks. There were three husk systems and 47 husk fragments. In the 1948 collection we found in Stratum II a long husk which shows no evidence of ever having been shaped around an ear. Furthermore its peduncle as well as the peduncle of the ear which it once bore are both quite slender. A cob which might have been enclosed in this husk system was illustrated in Plate XXVII of the 1949 report. Because this cob is much shorter than the husks, we reached what we then considered an "almost inescapable conclusion" that husks at this stage in the evolution of maize did not tightly enclose the ear but instead were involucre of leaf sheaths, not greatly modified, surrounding the base of the pistillate inflorescence but not completely enclosing it. "Inescapable conclusions" sometimes turn out, when additional evidence is forthcoming, to require modification. The additional evidence from the 1950 collections suggests that a long husk of this type enclosed not a single ear but a cluster of ears. This evidence comes from two specimens: one husk system (Plate V, B) in which the husks are only slightly longer than the 1949 cob which is illustrated in Plate VI, B and the other a piece of stalk with an attached slender peduncle bearing at the base the scar of a branch (Plate VI, D). Considering all of these specimens together we now reach the conclusion that the long husk probably enclosed a cluster of at least two ears, each of which had its own husks which were only slightly longer than the ears. The situation is illustrated in the

diagram in Fig. 3. The specimens on which it is based are illustrated in Plate VI.

That this conclusion may be more nearly correct than the earlier one is supported by the fact that in our genetically reconstructed wild corn produced by combining components of the tunicate locus with genes from various popcorn varieties, we have encountered exactly this situation: clusters of small ears each enclosed in short husks and the entire cluster enclosed in long husks which flare open at maturity.

FIG. 3. Diagrammatic longitudinal section based on specimens illustrated in Plate VI showing how the long husks may have enclosed a cluster of short ears, each enclosed in its own husks. Solid lines represent actual specimens; broken lines indicate what may have been the additional parts.



### TASSELS

Only one specimen of tassel, a fragment of a central spike, was found and this occurred in the uppermost level. Its spikelets have relatively long glumes. Since the specimens of tassels found in the 1948 excavation, although described, have not been illustrated, we are

including a photograph of them in Plate VII. The spikelets on most of the fragments are smaller and more delicate than those of the majority of modern varieties but in other respects are similar.

#### CONCLUSIONS

1. The earliest maize from the second (1950) Bat Cave expedition is more primitive than any of the specimens turned up in the first (1948) expedition.

2. Maize from the lower levels of the cave is definitely a popcorn. There are several popped kernels among the prehistoric remains and other prehistoric kernels proved to be still capable of popping after having their moisture content raised.

3. The earliest maize is probably a form of pod corn. At least it has relatively long soft glumes partly enclosing the kernels which are borne on long rachillae. These are characteristics of pod corn.

4. The maize from the lowest levels has brown pericarp color and is related to the Mexican race, Chapalote. Brown pericarp color is presumably the primitive or "wild" color. Brown pericarp is less frequent than red and colorless pericarp combined in the upper levels of the cave.

5. The occurrence of variegated pericarp in the 36-48'' level shows that a mutation system similar to that involving the "modulator" factor was in existence at an early stage in corn's domestication.

6. Clear-cut evidence of the introgression of teosinte or *Tripsacum* or both appears in the 36-48'' level of the cave and there is some evidence of introgression in the earlier 48-60'' level.



7. There is an increase in diameter of the rachis of the cobs from the lower to the upper levels; this is accompanied by an increase in kernel-row number and in the length and width of the kernels. There is a slight decrease in kernel thickness.

8. The remains of the husks and other parts of the husk systems suggest that the long husks found in one of the levels of the 1948 excavations enclosed not a single ear but a cluster of ears each enclosed in its own husk.

9. Comparisons with the prehistoric maize of other sites suggest that the earliest maize from Bat Cave should be dated at not earlier than 2300 B.C. and perhaps several centuries later.

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PLATE I. A and B. Two views of a segment of a disarticulating "tripsacoid" cob from the 24-36'' level. The pedicellate member of each pair of spikelets is staminate. The kernels have brown pericarp and are almost completely enclosed by the glumes. With respect to the pistillate spikelets, this is a four-rowed ear. C. Tripsacoid cob from the 36-48'' level showing highly indurated tissues of the rachis. Approximately half of the pistillate spikelets are solitary. D. This specimen appears to be the pistillate basal part of a tassel branch or an unbranched tassel. E. A tripsacoid cob from the 36-48'' level showing highly indurated tissues of the rachis, a whorled phyllotaxy, and a solitary spikelet. F. Fragment of a cob from the 36-48'' level showing the almost square shaped cupules which are similar to those of the prehistoric wild corn from Tehuacán Valley. All photos  $\times 3.7$ .

PLATE I

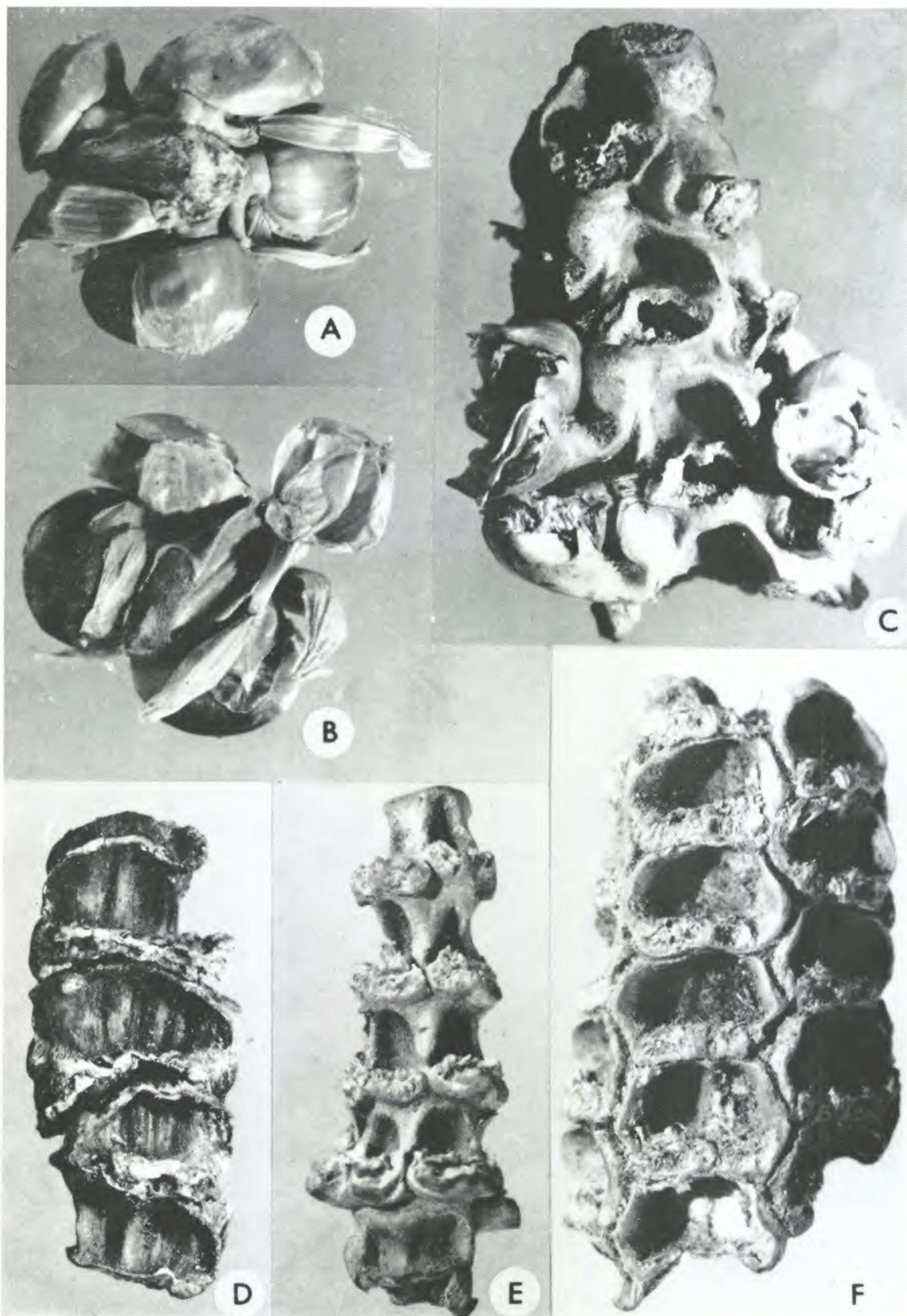
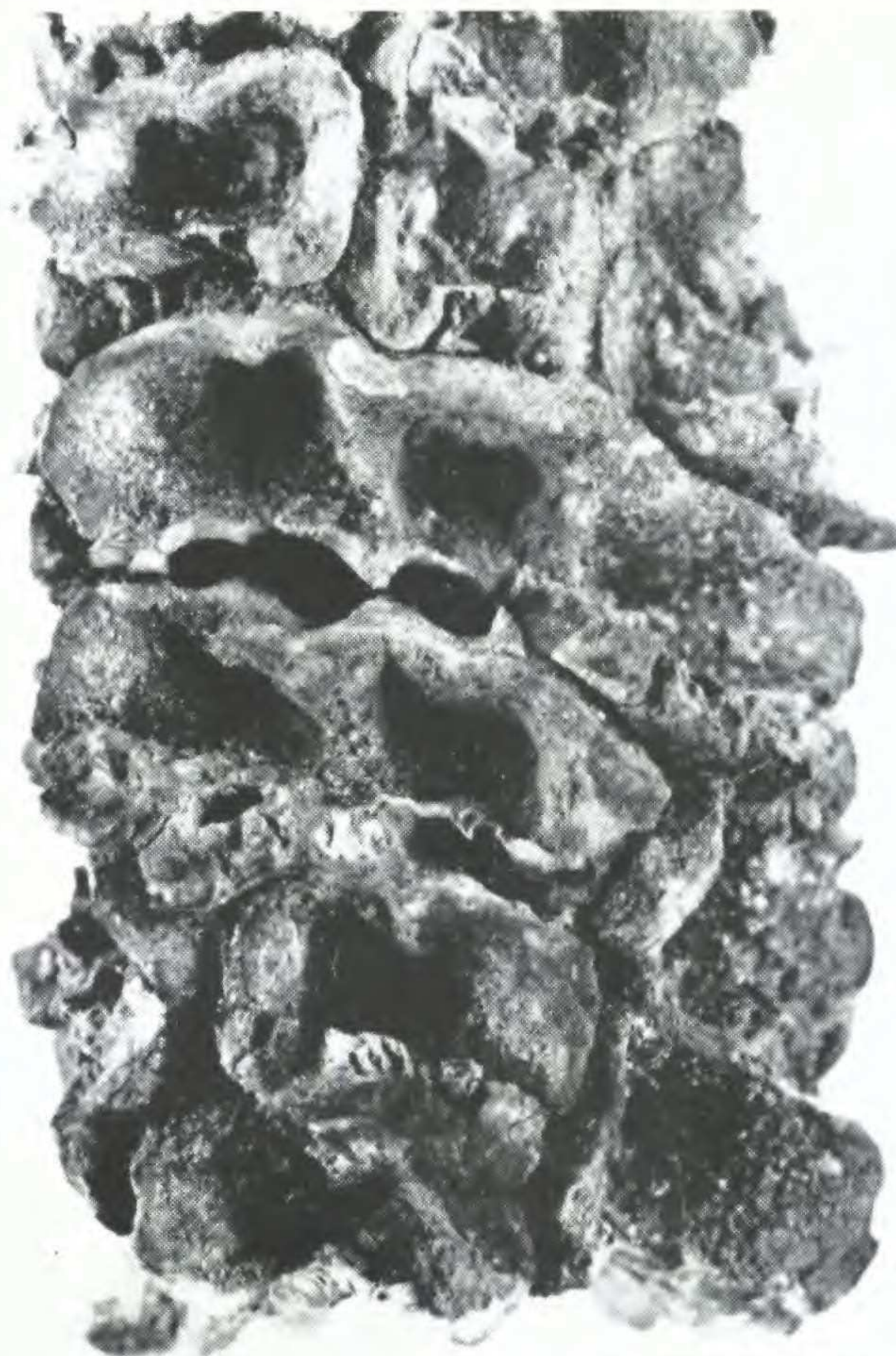


PLATE II. A. A well preserved cob from the 48-60'' level showing relatively long, soft lower and upper glumes and one cupule with a spikelet removed illustrating prominent cupule rims. This cob appears to be that of a form of pod corn. B. Fragment of an eroded cob from the 36-48'' level showing a tendency for adjacent cupules to fuse and their rims to disappear. C and D. Two views of a fragment of an ear from the 36-48'' level showing (1) the slender rachis and the long lower glumes and paleas and (2) the small round kernels with brown pericarp partially surrounded by the glumes and other floral bracts. All photos  $\times 3.7$ .

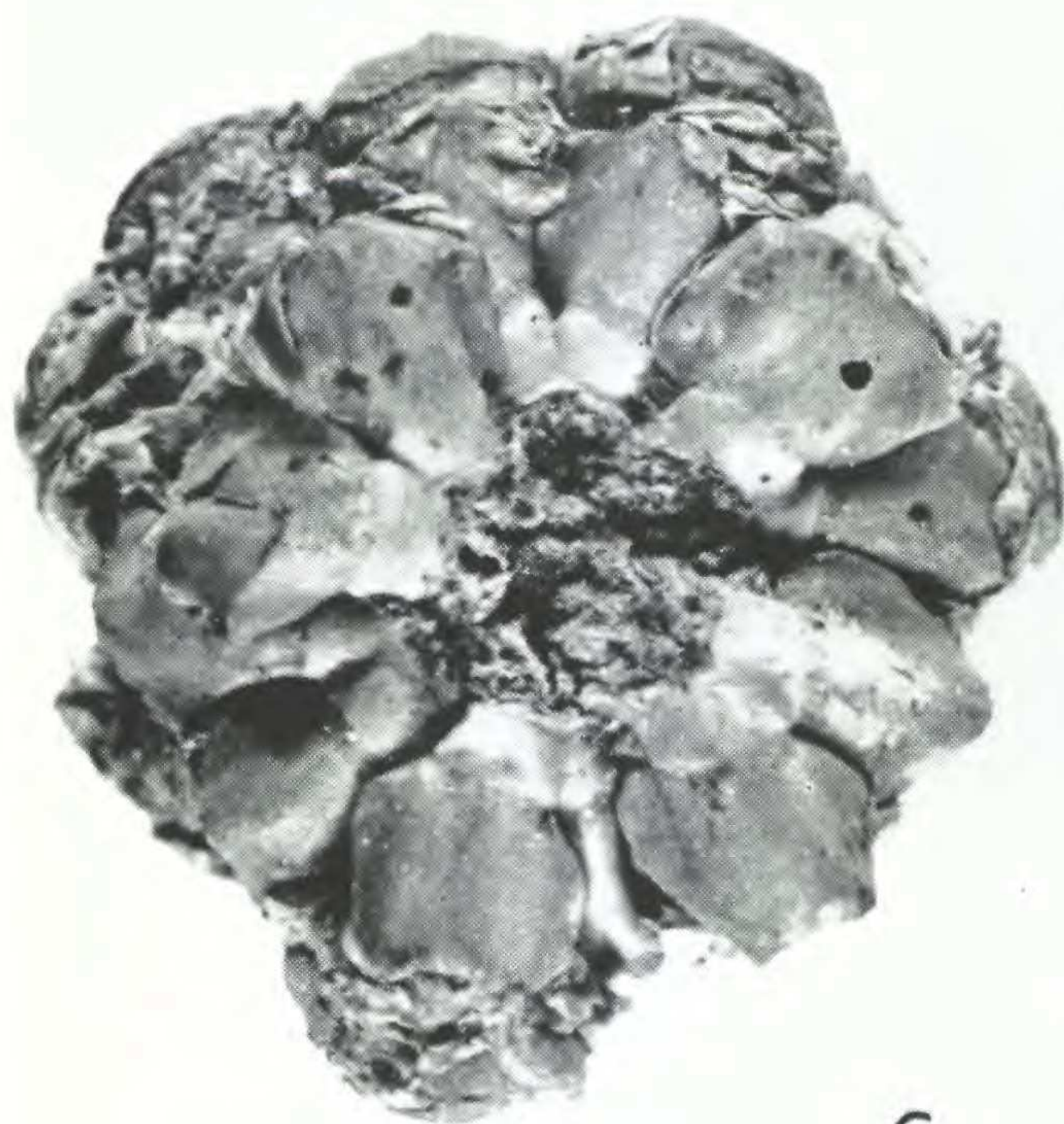
PLATE II



A



B



C



D

PLATE III. A. Three cobs from the lowest level of the 1950 excavation. The diagrammatic longitudinal section illustrated in Fig. 1 is based on one of these. B. An evolutionary series of Chapalote-type cobs, the shortest from the 48-60'' level, the longest from the 12-24'' level. C. Typical kernels with brown (left), red (center), and colorless pericarp. D. A prehistoric popped kernel from the 36-48'' level compared with a popped kernel produced by exposing a prehistoric kernel from the same level to heat. All photos actual size.



PLATE III

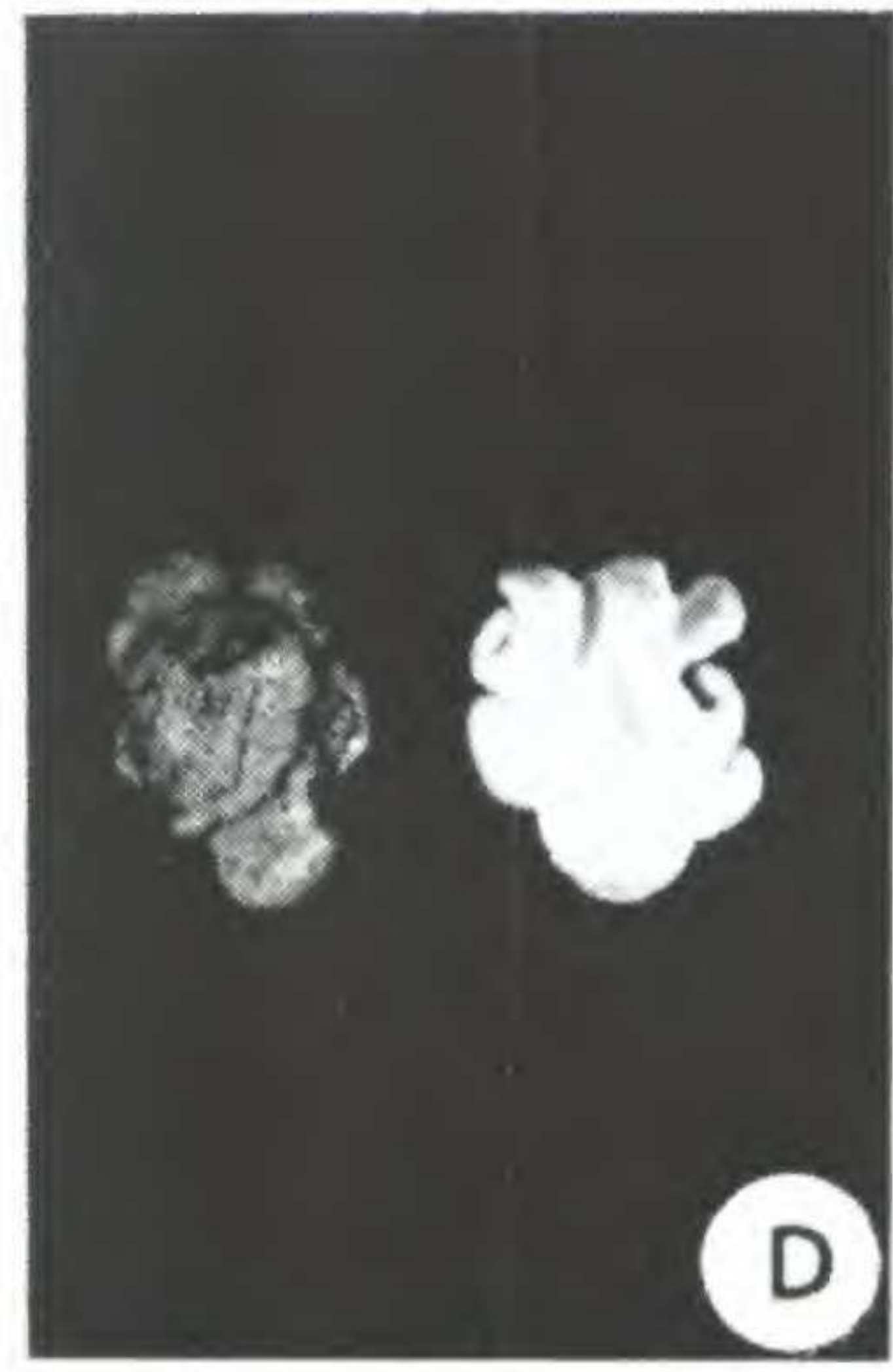
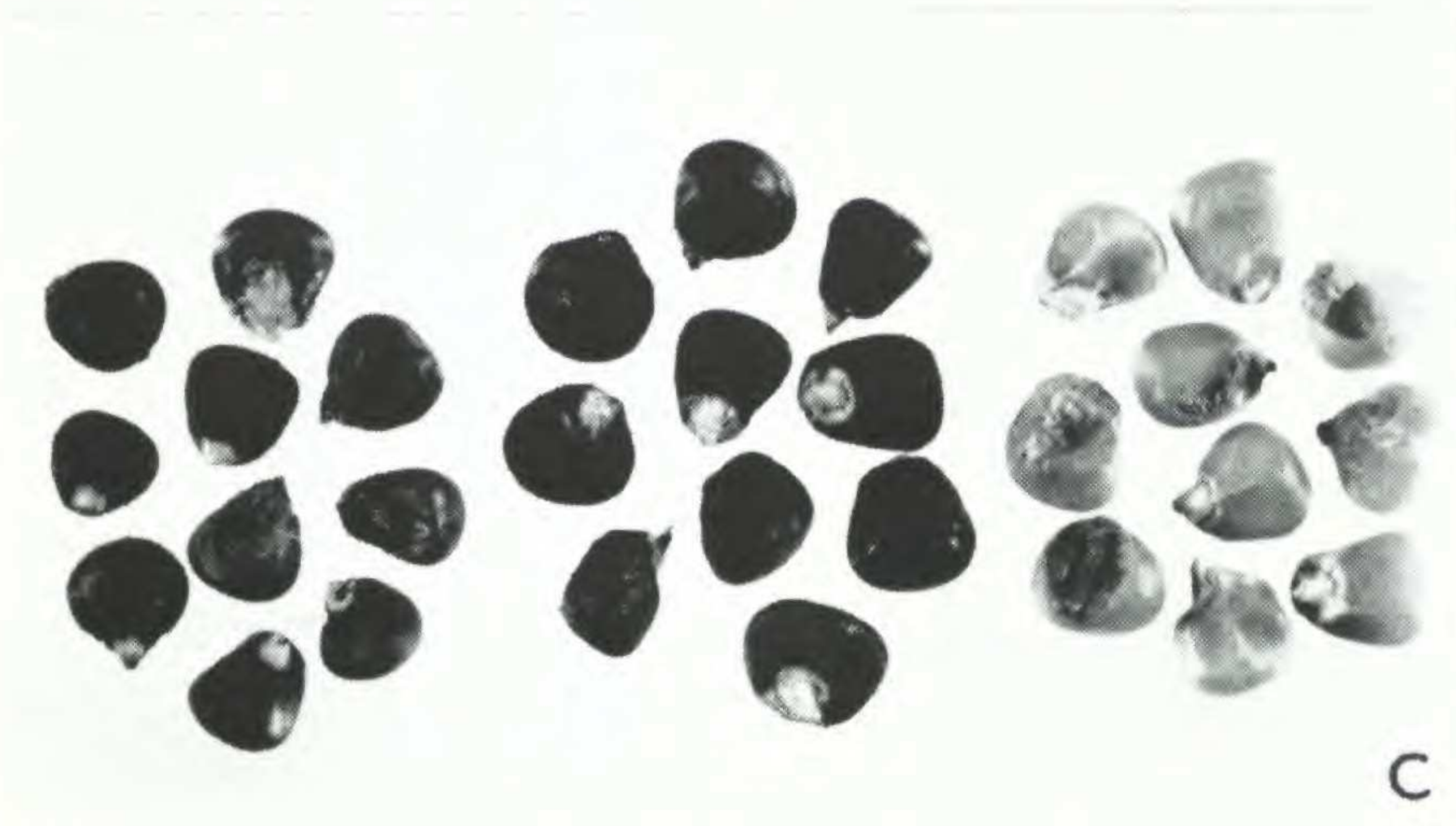
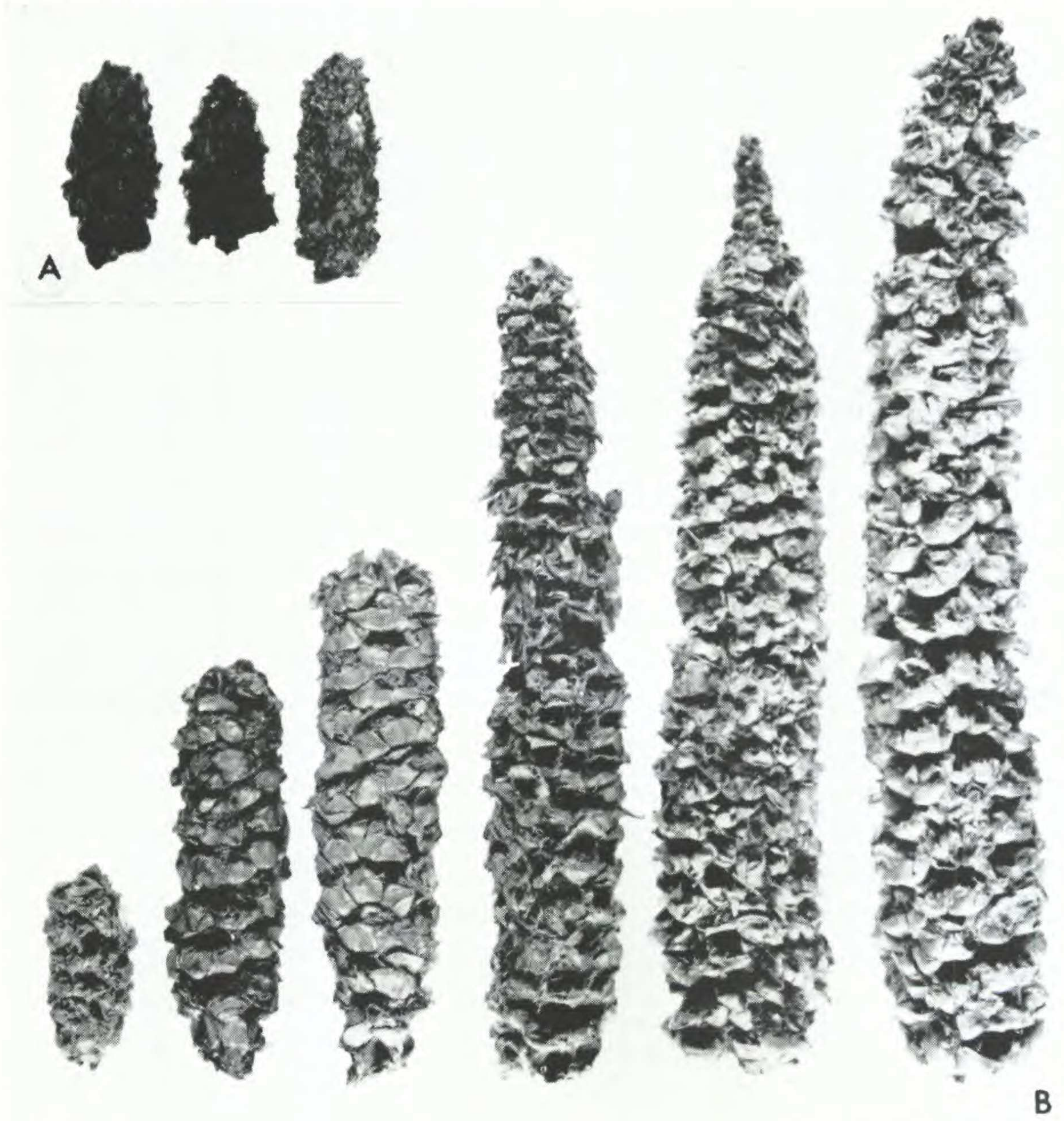
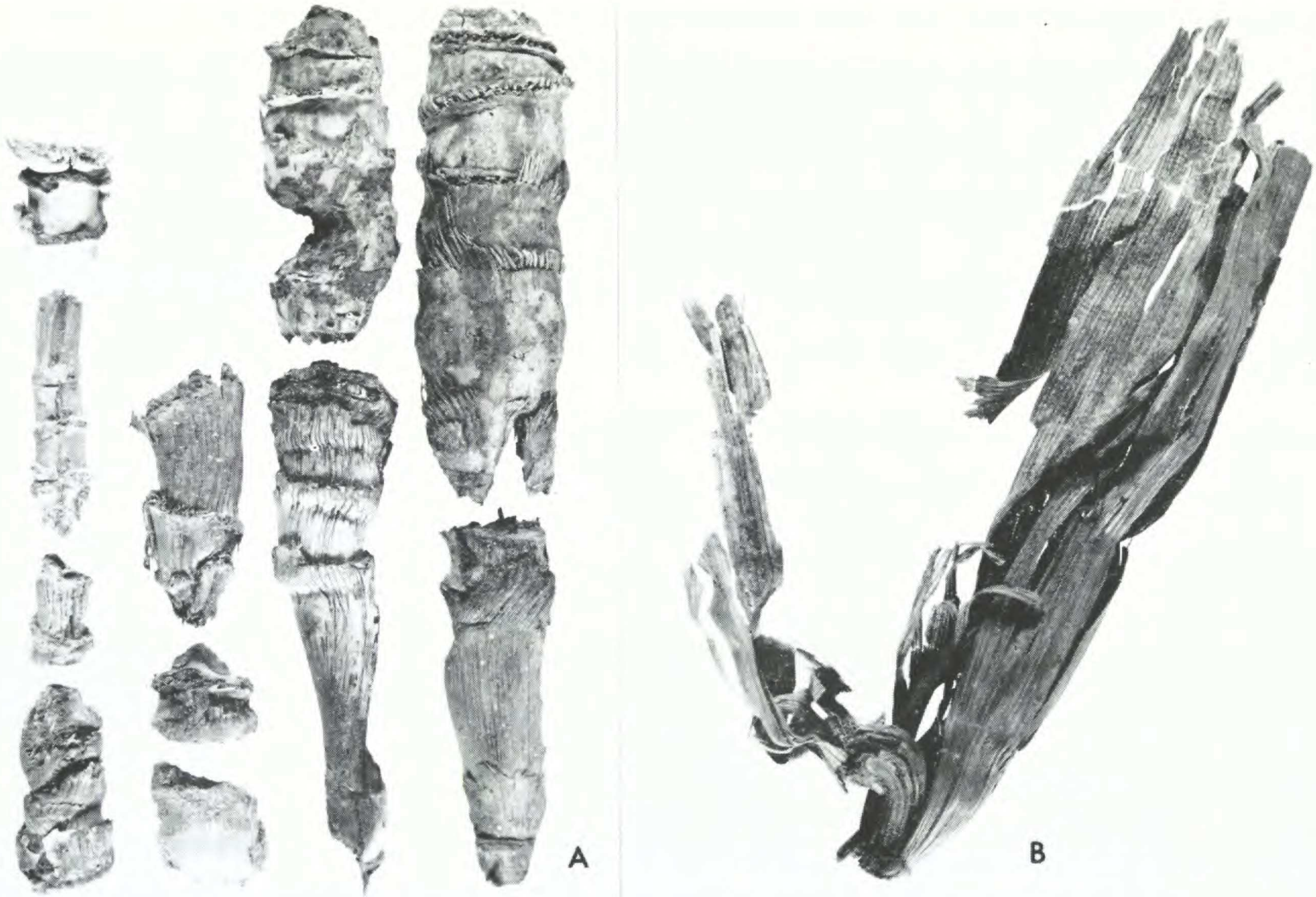


PLATE IV



Typical cobs related to the Mexican race, Blando de Sonora from the 23-36'' levels.

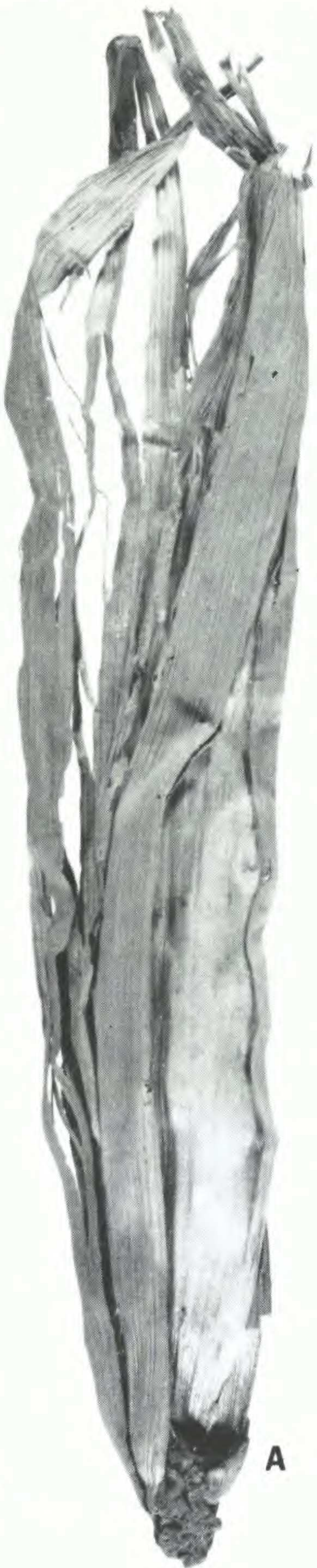


A. Specimens of peduncles arranged in sequence from the lower to the upper levels. The vertical rows represent the 36-48", 24-36", 12-24", 0-12" levels respectively. B. Remains of husk system from the 36-48" level. Actual size.

PLATE VI. A. A long husk from level II of the 1948 excavation. B. A Chapalote-type cob from the 1948 collection. C. A husk from the 36-48'' level which might have enclosed an ear of about the size represented by the cob in B. D. Piece of a stalk from the 36-48'' level with peduncle of an ear arising from it. At its base the peduncle has the scar of a branch. E. A slender peduncle of about the diameter of the branch once attached to the base of D. These specimens are combined in a diagrammatic longitudinal section in Fig. 3. Three fourths actual size.

PLATE VI

1  
1  
1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
CM.



A

B

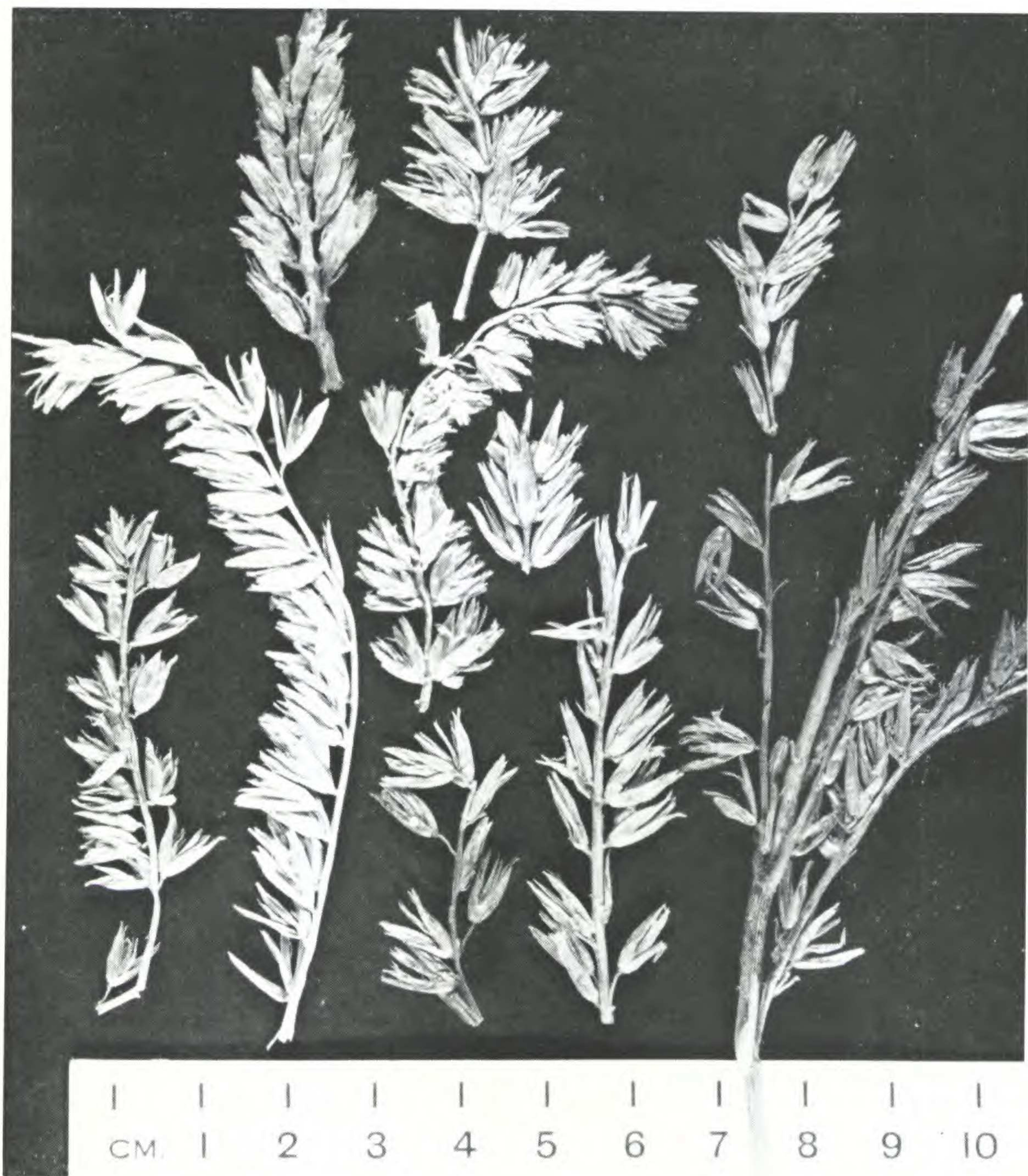
C

D

E



PLATE VII



Fragments of tassel branches from the 1948 excavations. The vertical rows from left to right represent levels VI, V, IV, IV, IV respectively.